

**Oroville Facilities Relicensing Efforts
Draft Narrative Reports for PM&E Discussion**

Resource Action: EWG-13A

Task Force Recommendation Category: 1

Proposed Large Woody Debris Placement in the Low Flow Channel

Date of Field Evaluation: April 28, 2003

Field Evaluation Team: Richard Harris, Carin Loy, David Olson

Proposed PM&E:

PM&E consists of a proposal to place large woody debris (LWD) in the low flow channel. The intention is to improve rearing habitat for anadromous fish, improve geomorphic processes and enhance opportunities for recruitment of riparian vegetation.

Related PM&Es:

- EWG-13B, that would be designed to improve rearing habitat in the low flow reach through placement of wood and other materials.
- EWG-16A, that would be designed to create side channel habitat in the low flow reach.
- EWG-89, that would involve levee setbacks and increased floodplain accessibility.

Potential Environmental Benefits:

LWD contributes to a variety of geomorphic and ecological functions in rivers and streams. It can help create holding and/or rearing habitat for salmonids and other fishes. For example, smaller woody debris can enhance the complexity of rearing habitat. Larger wood can redirect stream flow to create scour pools that serve as holding habitat. LWD can store and organize sediment into geomorphic surfaces where riparian vegetation recruitment can occur. Decaying LWD provides a source of instream nutrients for aquatic organisms. Generally, the influence of LWD on stream geomorphology and ecology varies with stream size (Lassette, N.S. and R.R. Harris. 2001. *The geomorphic and ecological influence of large woody debris in streams and rivers*. Report prepared for the California Department of Forest and Fire Protection, Fire and Resource Assessment Program, California Department of Forestry and Fire Protection, Sacramento, CA. 69pp.). On larger streams such as the Feather River, the role of LWD may be limited, although it can be locally important. Most LWD in larger streams is found on floodplain surfaces and at the periphery of the channel. Individual pieces or aggregations of LWD (i.e., debris jams) are less frequently found in mid-channel locations. Stream scale precludes individual pieces or jams from spanning larger streams. Nevertheless, on larger streams LWD can provide shelter for salmonids and when associated with secondary channels, it can help create rearing habitat.

Conditions in the Proposed PM&E Implementation Area:

The low flow channel of the Feather River is a regulated stream reach. Flows are nearly always about 600 cfs, except when peak runoff events require flood control releases

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from Lake Oroville. During those events, flows may exceed 100,000 cfs for sustained periods. Flows of this magnitude occurred in 1965, 1986 and 1997.

The low flow channel is generally confined between levees. There are some mid-channel bars, lateral bars and islands which are stable within the current flow regime. The slope gradient in the low flow channel ranges from 0.06% to 0.2%. Flow widths vary from 200-500 feet at normal regulated flows of 600 cfs to 2,500 feet at flood control flows of up to 100,000 cfs. Water velocities range from 1 to 4 fps at 600 cfs to approximately 12 fps at 100,000 cfs.

Riparian vegetation along the low flow channel generally consists of a gallery of mature cottonwoods along the banks and a variety of native and exotic trees, shrubs and herbaceous species both on banks and on islands. Openings available for natural regeneration of riparian species are limited and competition from exotics is extreme. Most existing openings have coarse textured (cobble) substrate, which is unsuitable for regeneration of most native riparian species.

Due to the riparian vegetation composition and distribution, potential on-site LWD contributions in the low flow channel are very limited. The only recruitment mechanism is bank erosion. The upstream Oroville facilities prevent LWD recruitment from upstream sources.

Surveys of LWD in the low flow channel have recently been completed but the data have not yet been entered into a data management system. By the end of August, these data will be available. They will show LWD amounts by position (bank, mid-channel, side channel) for the low flow channel. Initial impressions indicate that LWD loading in the low flow reach is lower than the loading in the lower Feather River. As a result, there is relatively limited diversity of instream habitat contributed by LWD.

Upstream sediment delivery to the low flow reach is also blocked by Oroville facilities. No active sediment recruitment or bench formation is presently occurring in the low flow reach.

The low flow channel is an intensively utilized spawning area for anadromous salmonids. Juvenile salmonid rearing habitat quality and quantity could potentially be improved though increased medium to high complexity LWD availability.

Design Considerations and Evaluation:

Most LWD placement projects have been done in small to medium-sized streams, especially on the north coast of California. Guidelines for LWD placement generally warn against projects in streams that are overly wide or overly steep. LWD placements have rarely been done on larger streams or rivers in California that are comparable to the low flow channel portion of the Feather River. When they have been done on larger streams, logs extending from banks into the channel have been used to create local scour pool habitat. The success of such projects has been variable.

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For LWD structures to perform well, variable flows and sediment must be available. Wood works with variable flows and sediment to create habitats. For example, scour pools are created by the acceleration of flows during floods immediately downstream from a log structure. In the absence of variable flows or appropriately sized sediment (as in the low flow channel), wood placement will create static habitat conditions (i.e., additional instream shelter).

Generally, the size of logs used in a placement project should correspond to the size of the stream. Spanning LWD structures must be longer than the bankful width (200-500 feet in the low flow channel) and at least 50 % of the bankful depth in diameter. Using spanning LWD structures in the low flow channel is not feasible given the width and the depth of the Feather River there.

As a rule, LWD placements are usually done as single logs, groups of logs or combinations of logs and boulders that are commonly anchored or cabled together. Some of the most creative placement projects involve the use of unanchored wood, often large "key" pieces that serve as collecting points for debris jams. This approach would not be workable in the low flow channel because of the size of the stream and the high flood control flows.

Wood may be anchored at banks with cable, between existing trees or with excavation. In these cases, the wood can provide some shelter habitat. However, wood may also deflect flows and exacerbate bank erosion. Anchoring often fails at higher flows than the low flow channel experiences during flood control.

On larger streams in the Pacific Northwest, there has been some work with "engineered log jams". These consist of cabled and anchored large logs commonly placed at the head of islands or side channels. Although these are expensive to construct, they have been shown to increase sediment recruitment and create sites for riparian vegetation recruitment. Such an approach in the low flow channel might yield some benefits but unless this LWD placement was combined with a "sediment placement PM&E" the lack of upstream sediment recruitment would reduce the enhancement potential of this LWD placement strategy.

In the low flow channel, probably the best opportunities for LWD placement are in backwater and side channel areas away from the thalweg. Mesohabitat maps of side channel and backwater habitats are currently available from SP-G2. LWD in backwaters and side channels may not effectively create additional rearing habitat or sites for riparian recruitment due to the regulated flow regime and lack of sediment available for recruitment. Medium to high complexity LWD placements in these areas may enhance juvenile salmonid rearing habitat diversity and quality for the life of the placement (until the next high flow event) or until the break down of the material into lower complexity LWD. There is also the potential that these backwater LWD placements would become refuges for predators of juvenile salmonids.

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Recommendations:

The feasibility of enhancing instream shelter habitat through medium to high complexity LWD placement in the vicinity of islands and backwater in the low flow channel should be evaluated by the Environmental Work Group to determine the merit of further investigation and development. Use of wood in conjunction with the creation of side channel habitat and riparian enhancement measures (EWG 16A), and sediment recruitment/enhancement (EWG-18/90, EWG-91/92) could also be considered. Issues to be considered for a proposed placement project would include:

- Potential benefits (e.g., improved fish shelter, downstream LWD contribution to habitat values of lower Feather River and Delta)
- Potential stability and longevity of placement (e.g. need for anchoring)
- Costs and logistics (e.g., LWD supply, O&M costs, etc.)
- Potential cross resource impacts (e.g. swimming and boating safety, bank erosion)

The costs for implementing LWD placements vary tremendously. Costs are incurred due to equipment needs, construction materials, and for the wood itself (unless it is freely available). The proximity of the low flow channel to the lake is a plus. LWD from the upper watershed is corralled in the lake and could be transported with minimal costs to proposed placement sites. Probably the main constraint would be gaining access to the river from the adjacent banks for heavy equipment.

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Resource Action: EWG-20

Task Force Recommendation Category: 4

LWD Placement in the Lower Feather River (below Thermalito)

Date of Field Evaluation: N/A

Evaluation Team: Richard Harris, Koll Buer, Bruce Ross and Tom Boullion. Review and comments by Dave Olson.

Proposed PM&E:

Add woody debris to the lower Feather River. Large woody debris would be anchored or inserted into the river at target locations to provide increased habitat complexity.

This Resource Action should be combined with EWG-13A.

Related PM&Es:

- EWG 13A and 13B that would place LWD and/or other structures in the low flow channel to enhance salmonid rearing habitat.
- EWG 19A and 22 that would involve using levee setbacks and/or geomorphic restoration in the lower Feather River to improve connectivity between the river and its floodplain.

Potential Environmental Benefits:

LWD contributes to a variety of geomorphic and ecological functions in rivers and streams. It can help create holding and/or rearing habitat for salmonids and other fishes. For example, smaller woody debris can enhance the complexity of rearing habitat. Larger wood can redirect stream flow to create scour pools that serve as holding habitat. LWD can store and organize sediment into geomorphic surfaces where riparian vegetation recruitment can occur. Decaying LWD provides a source of instream nutrients for aquatic organisms. Generally, the influence of LWD on stream geomorphology and ecology varies with stream size (Lassettre, N.S. and R.R. Harris. 2001. *The geomorphic and ecological influence of large woody debris in streams and rivers*. Report prepared for the California Department of Forest and Fire Protection, Fire and Resource Assessment Program. California Department of Forestry and Fire Protection, Sacramento, CA. 69pp.). On larger streams such as the Feather River, the role of LWD may be limited, although it can be locally important. Most LWD in larger streams is found on floodplain surfaces and at the periphery of the channel. Individual pieces or aggregations of LWD (i.e., debris jams) are less frequently found in mid-channel locations. Stream scale precludes individual pieces or jams from spanning larger streams. Nevertheless, on larger streams LWD can provide shelter for salmonids and when associated with secondary channels, it can help create rearing habitat.

Conditions in the Proposed PM&E Implementation Area:

The area considered in this evaluation is the lower Feather River between Thermalito and the confluence with the Sacramento River. Streamflow in the lower Feather River is

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mainly determined by releases from Lake Oroville to downstream water users and by inflow from major tributaries (Bear and Yuba Rivers). The streamflow regime is markedly different than a natural streamflow regime. Mean annual streamflow as recorded at gages at Oroville, Gridley, Yuba City and Nicolaus ranges from 4800 cfs to 8100 cfs. During the summer months, impaired flow is usually considerably higher than unimpaired flow. Mean monthly impaired flows are less than unimpaired mean monthly natural flows only in the late fall to late spring when the reservoir is filling.

Peak flows as recorded near Gridley were in excess of 150,000 cfs in 1965, 1986 and 1997. Under these conditions overbank flooding is widespread. Lesser, but still significant floods have occurred in 12 of the last 42 years based on the Gridley gage.

The regulation of moderately-sized peak flows in the lower Feather River may affect natural recruitment of LWD from bank erosion. However, this does not seem to be reflected in LWD inventory data for the lower Feather River (see below). Data on bank erosion will be forthcoming from SP-G2.

The channel below Thermalito is highly variable in its geomorphology. It is about 59 river miles from Thermalito to the Sacramento confluence. The entire length is classed as Rosgen stream type F, entrenched. Substrate becomes increasingly finer downstream and is mostly sand from RM 39 down to RM 0 at the Sacramento. Reach sinuosity varies from low (straight channel) to high (at RM 34-35). Levees are variably located. In some places they are located right on the channel. Other places they are set back considerable distances or absent. The effects of levees, as well as resistant geologic formations (e.g., Modesto Formation –lenticular silt and clay lenses) are to reduce overbank flooding and meandering. The lower Feather is deeply incised into hydraulic mining debris (10-25 feet), which further disconnects it from its floodplain.

There are some locations where there is a relatively high diversity of instream geomorphic surfaces. For example, between RM 39-54 there are multiple islands, bars and side channels. These areas of topographic diversity represent potential places where existing or supplemental LWD may enhance habitats for fish.

Under SP-G2 the occurrence of LWD in the lower Feather River has been mapped. Pieces larger than three inches diameter and three feet long were counted. Most pieces were twice that size. Larger pieces were up to 48 inches in diameter and 100 feet long. The smaller pieces were in log and debris jams. Although the data are somewhat incomplete, the preliminary results are revealing. Figure 1 shows the distribution of LWD pieces by channel position. Over 75 % of the counted pieces between RM 0 and RM 59 were located on either the right or left bank. The small amount of wood associated with backwater or secondary channels is a reflection of the rarity of those geomorphic conditions in the lower Feather River. Where secondary channels or backwater exists, the amount of LWD is relatively high (see Figure 3). Figure 2 shows the number of LWD pieces recorded by river mile. Although the values are highly variable, there is an increased abundance of wood in the section of the river where sinuosity and

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geomorphic diversity is relatively high. Most of the wood observed was either cottonwood or orchard trees, with some oaks. Recruitment was from the outsides of meander bends or from straight sections of stream. The primary recruitment mechanism is bank erosion although some orchard trees have been intentionally placed in the river (i.e., dumping). LWD appears to have a long residence time in the lower Feather River, probably because of the controlled flow conditions.

As a further illustration of conditions in the lower Feather River, Figure 3 is a map of LWD occurrence between RM 45 and RM 43. The accumulations at the entrance and exit to the backwater channel below RM 45 are notable. In this type of location on large rivers LWD can play an important role in providing fish habitat. Field observations indicated that in general, LWD in the lower Feather River is fairly abundant but has only localized effects on geomorphology and fish habitat. For example, between RM 44 and 43 (Figure 3) where the stream is straight, most LWD is positioned at the banks where it cannot exert much influence on the stream. However, LWD on banks can reduce bank erosion and provide shelter for fish.

At flows in excess of 5,000 cfs most of the LWD in the lower Feather River is submerged and not visible. Consequently, the LWD survey probably underestimated the true loading. The implications of LWD location for geomorphic and ecologic functions have not been analyzed.

Design Considerations and Evaluation:

In a river the size of the Feather, LWD placements need to be strategically located if they are to have effective and sustainable results. The present distribution of LWD in the lower river provides valuable information about where in the system wood tends to aggregate. These locations tend to have high geomorphic diversity and high sinuosity. These sites would be best for placements and placements there would likely provide the most benefits to fish.

Questions to consider for an LWD placement program would include:

- Is the present amount and distribution of LWD in the lower Feather River sufficient to provide potential geomorphic and ecological benefits?
- Could more benefits be gained by supplemental LWD placements and if so, where?

Among many fisheries scientists and geomorphologists the question of “how much LWD is enough” is not particularly relevant. It is usually clear when LWD is deficient but it is never clear when it is at optimum levels. To approach planning an LWD placement project for the lower Feather River the first step would be to identify the suitable locations. The next step would be to examine the existing inventory data to determine if LWD is clearly deficient. The sites that are suitable and deficient should have the highest priority for treatment. It would be best to coordinate the selection of sites for LWD placement with other Resource Actions that seek to improve fisheries habitat (EWG-19A, 22 and 89).

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The benefits of an LWD placement project in the lower Feather River should not be overestimated. Clearly there would be some benefits associated with placements in the low flow reach (e.g., retention of spawning gravels) that will not be attainable in the lower Feather River. The main benefits in the lower Feather River will be local improvements to instream shelter or rearing habitat for fish. LWD may also cause local deposition or scouring that will create some fish habitat or sites for riparian recruitment. LWD can also redirect flows and cause local bank erosion which may or may not be considered a positive effect.

Under the current regulated flow regime, LWD placements will provide some level of benefits until the next peak flow event. When that occurs, the magnitude of flooding will redistribute both naturally recruited and placed LWD. This redistribution process should not be considered a design problem but rather an opportunity for the river to define itself. In this regard, use of extensive anchoring devices to maintain LWD placements should be carefully considered and avoided if possible. Also, movement of LWD out of the Feather River during extreme flow events provides benefits downstream, perhaps as far as the Delta.

If additional measures such as an altered flow regime or geomorphic restoration are ultimately approved for the lower Feather River, the role of LWD placements should be carefully evaluated. LWD placements may complement these measures or be rendered ineffective by them.

The success of a LWD placement project can be evaluated through monitoring of the LWD structure over time. In some cases, fish monitoring might also be conducted to determine if LWD structures are attracting fish or providing habitat values. The choice of an approach for monitoring LWD will depend on the objectives of the specific placement project.

Recommendations:

This resource action should be combined with EWG-13A. There are sufficient data available to do further evaluation of this measure. Existing geomorphic mapping and reach classification provide data on potential sites for LWD placement to enhance resource values. An inventory of LWD occurrence has been completed. Those two pieces of information can be used to develop at least a preliminary opinion on where LWD may be deficient in the system. From there, more site specific evaluations should be conducted. Site specific considerations include:

- Potential benefits (e.g., improved fish shelter)
- Potential impacts (e.g., bank erosion, impaired navigation, etc.)
- Potential stability of placement
- Costs and logistics (e.g., LWD supply)

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Any site specific evaluation should be coordinated with the planning for other Resource Actions in the lower Feather River.

The costs for implementing LWD placements vary tremendously. Costs are incurred due to equipment needs, construction materials and for the wood itself unless it is freely available in the vicinity of the proposed treatment area. If coniferous trees are to be used because of their greater longevity and size, they will have to be brought in from the upper watershed. Depending on their size and quality, hauling trees can be a substantial cost. Costs need to be weighed against the real potential benefits of LWD placements in river systems like the Feather River, including improvement of salmonid habitat, contributing to the recruitment of riparian vegetation and providing sources of instream nutrients for aquatic organisms.